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THE SYMPTOMATOLOGY, DIAGNOSIS, AND SURGICAL TREATMENT OF CERVICAL RIBS.

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I HAD never seen a case of recognized cervical rib until October 20, 1905. Within less than a month, personally or through Drs. Hearn, Patterson, and Taggart, of the surgical department of the Jefferson Medical College Hospital, I saw four other suspected cases, of which two proved not to be cervical ribs and two others were. Of the last two, only one needed operation (Patterson's). The history of the patient operated on by myself is as follows:

Mrs. M. A. R., aged sixty-three years, entered the Jefferson Hospital October 20, 1905, at the request of Dr. F. R. Brunner, of Eshback, Pa., who kindly furnished me with the following facts:

Her father died of some disease of the heart and her mother of typhoid fever. Nine brothers and sisters are living and well.

In childhood, she had measles, mumps, whooping-cough, chicken-pox, and scarlet fever, and at the age of twenty-three years, typhoid fever. From all of these she made good recoveries. She has had several attacks of rheumatic fever. She was married at thirty, and has had one child. Her general health has been very good.

At the age of seventeen years she noticed a lump above the left clavicle. Although its presence did not cause her any trouble, she consulted a physician, who told her it was a "bone." She never had any trouble from it until last February, when, upon rising in the morning, she noticed that the first and second fingers of the left hand were the seat of sharp stinging pain, and that they were much paler than the others and cold to the touch. Brisk friction for a few moments would cause these symptoms to disappear. About a week later the thumb and the remaining fingers also became involved. A few days later she complained of a constant sharp stinging pain in the left hypothenar eminence. In the course of a few days this pain extended up the ulnar side of the forearm to the elbow, the radial side becoming involved soon afterward. Later, the pain extended up the arm to the shoulder. It was so severe as to cause her to lose considerable sleep. With the onset of the pain, the left hand became distinctly less red than the other. During last June the pain gradually disappeared. About the first of September, she again noticed a tingling sensation and shooting pain in the finger-tips of the left hand, and that the fingers were red and slightly swollen. About two weeks later the soft parts at the tips of the fingers, especially under and about the nail, became gangrenous in the following order: index, ring, thumb, middle, and little finger. She stated that the pain was always less severe while she used the hand freely in her work.

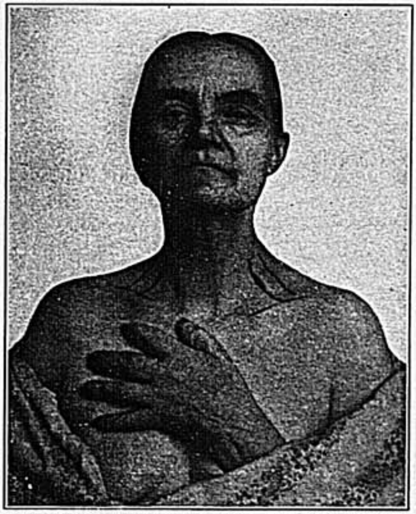

FIG. 1.—Photograph of Keen's case of cervical ribs. The obliquely horizontal lines correspond to the clavicle. The double obliquely vertical lines correspond to the subclavian arteries. The gangrene of the finger-tips shows imperfectly.

Physical Examination on Admission. Weight 119 pounds. There is no arcus senilis present. There is a soft systolic cardiac murmur heard best at the apex. The lungs are apparently normal. There is no pulse whatever in the axillary, brachial, radial, or ulnar arteries on the left side. The left subclavian can be felt above the left clavicle running downward and outward to the clavicle for a distance of 6 cm. (Fig. 1). Its width as ascertained by putting one finger upon each side of the vessel, and including, of course, two layers of skin and subcutaneous tissue, is 18 mm. It pulsates very strongly to the touch. Though there is no thrill, a stethoscope applied over the artery reveals a local bruit which is not propagated. Behind the artery is a rounded swelling above the left clavicle a little internal to the junction of its middle and outer thirds. On deep palpation this swelling is found to be part of a hard bony mass which can be traced backward to the spinal column. As it curves forward it seems to pass behind the clavicle. The artery passes in front of (that is, over) this bony prominence, which was diagnosticated as a cervical rib.

The left hand is distinctly cold and very much paler than the right. The nail of the middle finger is entirely loose and there is an ulcerated surface corresponding to the site of the nail, passing through the tip of the finger midway between the dorsal and the plantar surfaces. The other four nails are discolored and the tips of the fingers are somewhat ulcerated, the worst being the ring finger. This ulceration is the result of the sloughing off of the slight gangrenous patch from the subungual space (Fig. 1).

A slight bruit can be heard over the right subclavian, but it is much less distinct than that over the left. There is no thrill on either side.

Behind the right subclavian artery also a cervical rib is present and can be traced back to the spine. Both of the cervical ribs are immobile. A skiagraph (Fig 2) shows bilateral cervical ribs, the left being the larger rib.

The right subclavian artery also runs much higher than is usual and can be traced upward from about the junction of the middle and outer thirds of the right clavicle for a distance of 3.5 cm. Its width, measured as already estimated on the opposite side, is 15 mm. These measurements for the diameter of the vessels naturally should not be taken too exactly. The pulse on the right side is normal. The muscles of the left shoulder and the entire arm are considerably wasted. This is due in some measure to non-use of the hand, for all of the joints of the fingers, from having been kept of late quiescent and part of the time poulticed, have become partially ankylosed.

The right arm at the middle of the biceps measures 24.5 cm.; the left arm, 24 cm.; the right forearm, 8 cm. below the external condyle 20 cm.; and the left forearm, 8 cm. below the external condyle 18 cm.

Neither inspiration nor elevation of the right arm has any effect upon the pulse. The urine is normal except for a rather low percentage of urea.

Dr. Alfred Gordon kindly examined her, and confirmed the above findings and also found marked tenderness and hyperalgesia in the hand. Sensation in the arm and forearm is very slightly diminished. The temperature sense is normal.

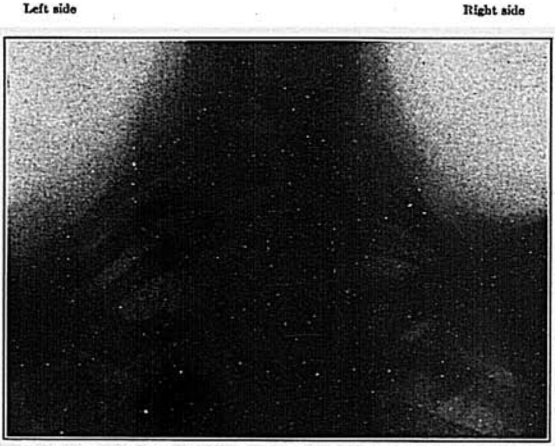

FIG. 2.—Skiagraph of Keen's case, showing bilateral cervical ribs, the left being the larger and higher and the only one causing symptoms.

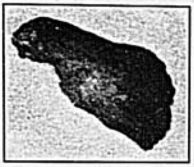

FIG. 3.—The piece of rib removed in Keen's case (natural size). Note the knob at about its middle. This formed the tumor felt behind the subclavian artery.

Operation November 29, 1905. An incision just above the left clavicle and parallel with it, a second vertical incision directly over the tumor, and dissection of the internal and external flaps, gave ready access to the tumor. This was found to consist of the subclavian artery and immediately back of it a cervical rib—attached to the seventh cervical vertebra and immovable. The attachment to the first rib just behind the middle of the clavicle was broad, and relatively thin, partly fibrous, but chiefly bony. The middle of the rib consisted of a large knob of bone (Fig. 3). The brachial plexus as well as the subclavian artery ran over the cervical rib. The cords of the plexus instead of being cylindrical were markedly flattened. By displacing the artery first inward, then outward, I was able to expose thoroughly the anterior end of the bone, to which part the scalenus anticus was attached, and to detach this muscle from the bone by scissors. Then displacing the artery internally and the nerves externally, I was able to uncover the posterior end and separate the surrounding tissues from it. With a pair of bone forceps I divided the bone posteriorly and anteriorly, removing the periosteum with it. The fibrous part of the anterior end was divided by scissors, the parts underneath being guarded by the handle of an instrument. I was particularly careful at this point, fearing every moment that I should tear the dome of the pleura. At no time, however, did I see the pleura nor was it injured, nor was the subclavian vein seen at any time. With a pair of rongeur forceps I then smoothed off the two ends of the bone. The artery where it emerged from the behind the scalenus anticus seemed to be smaller in diameter than usual. It changed its course downward and outward abruptly by a sharp bend (Fig. 4). Immediately beyond the external border of the muscle it was dilated to nearly twice the

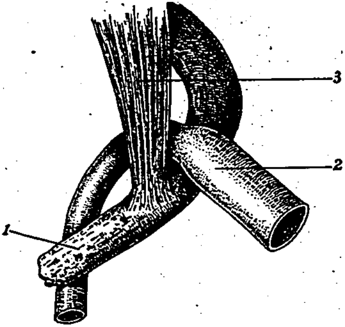

FIG. 4.—Keen's case. Sketch showing the marked increase in size of the subclavian artery after escaping from behind the scalenus anticus. 1. Cervical rib. 2. Subclavian artery. 3. Scalenus anticus.

width of the vessel as it emerged from behind the scalenus anticus. Down to the point where it disappeared behind the clavicle it retained this enlarged diameter. Beyond that point it could not be followed.

A small cigarette drain was placed in the wound, which, after douching with salt solution, was closed by ordinary sutures. The patient was placed in bed in admirable condition.

In the afternoon of the operation her temperature rose to 100.6°. It was down to normal on the second day, and so continued until she went home. The cigarette drain was removed at the end of twenty-four hours, and the wound healed without note. I desired later to etherize her and break up the adhesions in the finger-joints so as to give her a more useful hand, but she was unwilling that this should be done.

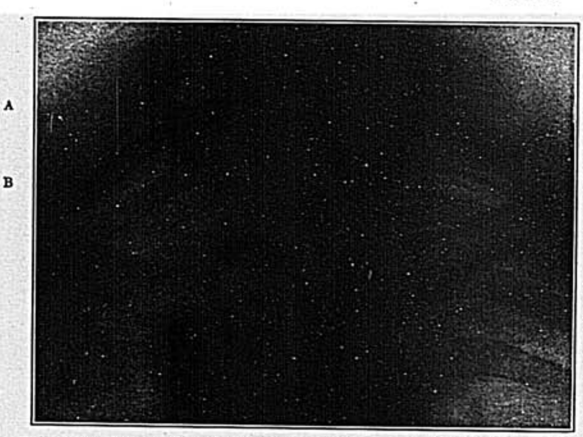

FIG. 5.—Keen's case. Skiagraph showing the gap in the cervical rib left by the resection Opposite A and B are seen the stumps of the two ends.

Immediately after the operation all pain disappeared from the left arm, and remained absent up to the time when she left the hospital, twelve days after operation. The bruit still persisted in the left subclavian, but there was no thrill. Pulsation was less evident than before the operation. The pulse did not return in any of the arteries below the subclavian.

Within twenty-four hours after operation the left hand assumed a much better color, and in the course of two or three days its temperature was almost the same as that of the right hand. Meantime the ulcerated spots on the fingers dried up and crusted over, so that she was no longer obliged to protect them even with a dressing.

A new skiagraph (Fig. 5) shows where the resection left a gap in the left cervical rib.

October 20, 1906. Eleven months after operation, Dr. Brunner reports that she does not suffer at all except from slight pain in the forearm when she works much. Her sleep is excellent. The subclavian is normal. There is very slight pulsation (?) in the axillary and ulnar arteries, none in the radial. The nail is absent only on the middle finger; the fingers are not painful. She cannot quite close them, but she uses her hand for all kinds of work, and it feels the same and is as strong as the other.

A cervical rib is a congenital vice of development. Unlike most other such defects, it usually exists alone. But it may be associated with other congenital defects. Thus, Ballantyne[1] mentions a case, a woman, aged twenty-two years, in which there was an imperforate vagina with distention of the uterus. Poland describes a case associated with club-foot. Borchardt, Oppenheim, Marburg, and Schönebeck mention cases associated with syringomyelia. Levi describes one with the symptoms of multiple scleroses; Spiller and Gittings published a case of progressive muscular atrophy of cervicobulbar type similarly associated. Most of these were defects of development of the central nervous system. I have not found any other defects either in the skeleton or the soft parts associated with cervical rib. Though the defect is congenital the symptoms, as I shall point out later, seldom develop early in life.

Most cases of supernumerary cervical rib are attended with very slight or more frequently with no symptoms whatever. In fact, the existence of the anomaly is often entirely unknown until discovered either by reason of some illness requiring examination of the neck, at a postmortem, or in the dissecting-room. It is often assumed that the specimens found in the dissecting-room have caused no symptoms. It is, however, by no means a certainty that they were without symptoms, for the clinical history of the cadavers is rarely known.

Although mentioned by Galen (see Hunauld) and other early authors, our real knowledge in reference to the existence of cervical ribs dates from the paper by Hunauld, published in 1742 (Fig. 6). In 1849, Gruber published a paper on "Cervical Ribs," and twenty years later, in a second paper, increased the number of known cases to seventy-six. He quotes the first two cases (Willshire and Huntemüller) in which the anomaly was recognized in the living. Three other cases recognized during life were added by Struthers, in 1875. In 1894, Pilling increased the number of reported cases to 139, of which nine had been recognized during life.

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[1] All the references are in alphabetical order at the end of the paper.

Since that time a large number of cases have been reported. Most of them are interesting only from the anatomical and embryological point of view.[2] These I do not propose to consider, but shall limit this paper chiefly to those which have been treated by operation, incidentally considering a few of the other cases which are of interest from the surgical point of view, either by reason of their symptoms, physical signs, or treatment. The appended list contains all the cases subjected to operation which I have been able to find, some of them from histories kindly furnished by the authors, to whom my thanks are due.

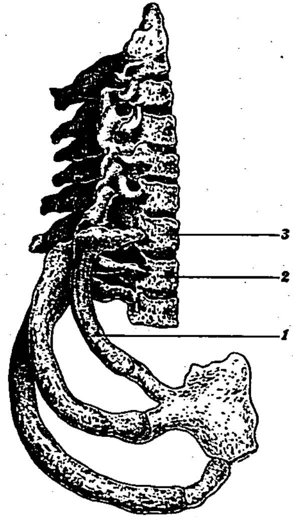

FIG. 6.—Showing a complete cervical rib. Cervical rib. 2. First dorsal vertebra. 3. Seventh cervical vertebra. (Hunauld.)

One of the chief reasons for the large increase in the number of cases reported in recent years is undoubtedly the discovery of the x-rays. In suspicious cases, examination by this method enables us to reach a decision whether or not such an anomaly exists. As a result of this positive method of diagnosis many cases which would otherwise have escaped observation have been definitely proved to be genuine.

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[2] Readers desiring to look these up should consult the bibliographies of Krausse (the fullest to date), Schönebeck, Eisendrath, and Riesman.

AGE. The age at which cervical ribs have been discovered varies from the sixth month of intrauterine life (Rosenmüller, Pilling) to old age. The age when the cervical rib produces symptoms, however, is far different. (*Vide infra.*) Symptoms rarely manifest themselves until adolescence. In other cases they do not arise until much later, though the patient has borne the rib since birth. The reason for this late onset of symptoms will be discussed later.

SEX. Why there should be such a disparity between the two sexes it is impossible to say, but it is at least curious to note that it is much more frequently met with in the female than in the male sex.[3] Among the 42 patients operated on, which I have collected, there were 31 females and only 11 males.

SIDE. Naturally one would expect the anomaly to be nearly, if not quite, equally frequent upon the two sides. As a matter of fact, we find that up to the time when Pilling collected his 139 cases (1894) it was believed to be bilateral in only about two-thirds of the cases. In all probability this does not represent the real percentage, because the smaller rib from its non-production of symptoms and difficulty of discovery has often been overlooked. The *x*-rays have demonstrated the far greater frequency of their bilateral existence. Thus, Schönebeck, in 1905, states that of eighteen skiagraphs, fourteen showed bilateral and only four a unilateral anomaly. In none of the fourteen was the rib equally developed upon both sides. Usually only the larger rib produces any symptoms. In fact, so far as I know, there are but two cases in which symptoms were developed on both sides (Rutkowski and Schönebeck).

In two cases there were two ribs on one side. Struthers records a case of rudimentary bilateral cervical ribs on both the sixth and seventh cervical vertebræ in the cadaver of a boy, aged four years, and Ehrich records another remarkable and, indeed, unique case, operated on by Karg, in which there were two cervical ribs attached to the sixth and seventh vertebræ. The subclavian artery passed *between* the two ribs in so narrow a space that full inspiration entirely obliterated the radial pulse. Stifler, in 1896, reported a case in which he believed the rib arose from the sixth cervical, but in the absence both of operation and a skiagraph, it is permissible to doubt. Beck believes that in his case there was a rudimentary rib arising from the sixth as well as from the seventh vertebra. In Hauswirth's and Williams' cases, the rib was erroneously reported as arising above the seventh vertebra.[4]

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[3] Drs. Thomas and Cushing (Johns Hopkins Hosp. Bull., November, 1903, xvi) call attention to an interesting passage in Sir Thomas Browne's Pseudodoxia Epidemica or Commentaries on Vulgar Errors, London, 1650, 292, on the supposed difference between the female and the male skeleton as to supernumerary ribs, which caused a very heated discussion based on the Biblical story of the creation of Eve. However, this, like Eve, is a "side issue."

With these few exceptions, the rib has always arisen from the seventh cervical vertebra.

Were this anomaly entirely an anatomical one, it would possess but little interest to the surgeon other than in operations on the subclavian artery or the brachial plexus. As in the cases of cervical rib, the subclavian artery lies much higher in the neck than usual, it lessens the difficulties of reaching the artery, but might mislead the surgeon were he not aware of the anomaly. Stanley Boyd mentions one case in which it was an advantage, as compression of the artery for aneurysm was greatly facilitated by the greater accessibility of the artery. But the cases in which symptoms arise may prove exceedingly serious and become of importance to the surgeon as well as to the neurologist, internist, and pathologist. The pain and disturbances of sensation which occur, the serious wasting of the muscles of the arm, the diminished if not total loss of usefulness of the arm, the partial or total obliteration of the pulse, the occasional gangrene of the fingers, and the occasional occurrence of aneurysm all make the lesion a matter of great surgical importance.

ANATOMY. A cervical rib is only an abnormal development of a normal portion of the vertebra. We are apt to forget that in the cervical, the lumbar, and even the sacral region there exists a representation of that which in the dorsal region is fully developed into a normal rib.

In the accompanying diagrams (Fig. 7), from Morris' *Anatomy*, one can see that while the "costal process" is fully developed into a true rib only in the thoracic region, potential ribs exist in all the other three regions of the spine in a rudimentary form.

It is interesting to observe that the most frequent site for the extra rib is from the lowest or seventh cervical vertebra, that is, the point of transition from the last cervical to the first dorsal vertebra, very rarely from the sixth, and only in one case (Völcker) above that. Occasionally also supernumerary ribs are developed in the lumbar region adjacent to the last dorsal rib.

The development of the cervical rib may vary simply from a slight

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[4] I have not included in my table of cases of cervical rib which have been operated on the case of Czerny and reported by Völcker, as the lipoma was the chief lesion and the rib was rudimentary and incidental. This very remarkable and unique case was one of fatty tumor of the neck, in a girl of fourteen. The tumor weighed a kilogram, was chiefly a deep lipoma, with areas of calcification and ossification. The pedicle of the tumor was a rudimentary rib connected with the transverse process of the fifth cervical vertebra. Völcker calls attention to the fact that lipomas frequently take their origin from congenital vices of development. He believes that in this case in all probability the tumor began in intrauterine life. This is the only case reported in the literature of a deep lipoma of the neck connected with the vertebral column and the only case of a rib arising above the sixth vertebra. There was no additional rib from the sixth and seventh vertebræ.

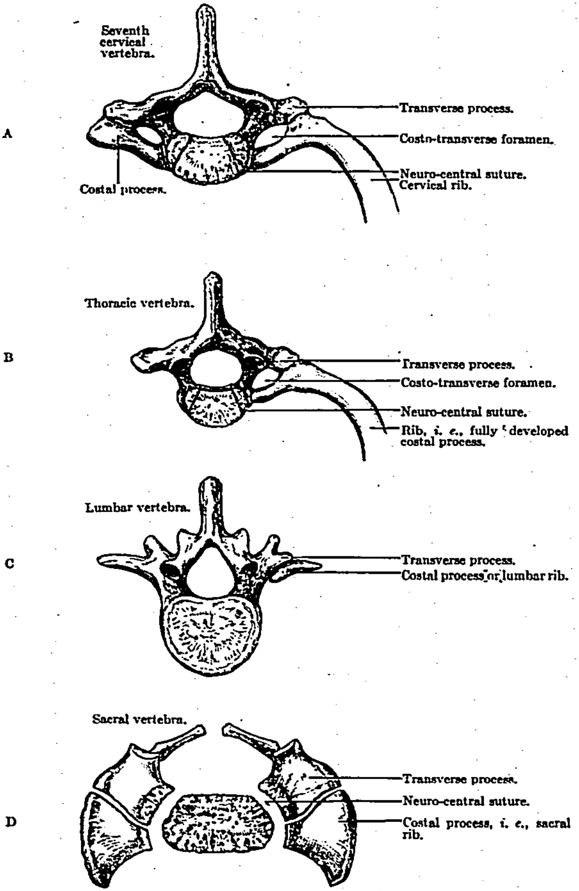

FIG. 7.—Note in A, on the right side of the seventh cervical vertebra, the costal process which on the left side is represented as a cervical rib. This costal process, or potential rib, exists in all the cervical vertebræ. In B, a thoracic vertebra, the fully developed costal process is a normal rib. In C a lumbar, and D a sacral vertebra, the costal process, *i. e.*, rib, exists in an undeveloped form. (Morris' Anatomy.)

exaggeration of the costal process of the seventh cervical all the way to a complete cervical rib attached to the sternum. Imperfect ribs are much more common than completely formed ribs. The best classification is that of Gruber into four degrees: First degree, a very slight increase of the costal process not reaching beyond the true transverse process. Second, a rib protruding beyond the transverse process to a moderate extent and ending either free in the tissues or attached in some way to the first thoracic rib. Third, a still further degree of development in which the cervical rib extends for a considerable distance toward or even to the cartilage of the first thoracic rib, possesses a complete body, and is united directly or by means of a ligament with the cartilage of the first rib. Fourth, a complete cervical rib uniting at the anterior extremity with the cartilage of the first rib through which it reaches the manubrium (Figs. 6 and 14.)

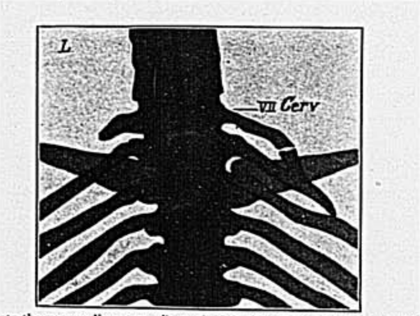

FIG. 8.—Note the very rudimentary rib on the left side; the larger one on the right side; the exostosis from the first dorsal rib with which the cervical rib articulates by a joint (Meyerowitz's Case 2.)

Dr. Lewellys F. Barker (an interested observer), in a private letter, states: "When I was in Europe, in 1904, I visited several anatomical museums and looked over the collections of cervical ribs. The best collection I saw was in Prague. The ribs showed the most remarkable diversity. Sometimes a cervical rib articulates behind with the body of the vertebra, sometimes with the intervertebral disk; in front it sometimes articulates with the first rib, sometimes with the sternum. Not infrequently there is extensive bony union between the cervical and the first rib. The length varies greatly. I saw very short nodules and all gradations between these and ribs running all the way to the sternum."

This is the fullest statement I have seen as to the variation in the vertebral attachment of the rib, except the important paper by

Drehmann. (*Vide infra* under Scoliosis.) It is to be noted that the vertebral attachment is sometimes by means of a complete joint, so that the cervical rib, like the dorsal ribs, is movable. In other cases there is no articulation; in this case the rib is immovable. Of course, if the anterior attachment of the rib is by a bony connection with the first rib, this also will render the tumor in the neck immovable. In several cases a joint has been noticed some distance from the first rib, in which case the specimen might be described as a cervical rib articulating with a longer or shorter exostosis from the first rib (Fig. 8). Not uncommonly this projection from the first rib, which, so to speak, rises up to a greater or less extent to meet the rib, is apt to be thickened at the point of junction, and produces a tumor consisting of two portions nearly at right angles to each other (Figs. 9 and 10; *cf.* Weissenstein, Ehrich (Madelung), de Quervain, Ranzi, Adams, Aron, Tilmann, and Borchardt). Commonly in the living subject the rib and the artery can only be traced to the level of the clavicle. Behind this they disappear and the anterior attachment of the rib can only be discovered by operation and sometimes not even then.

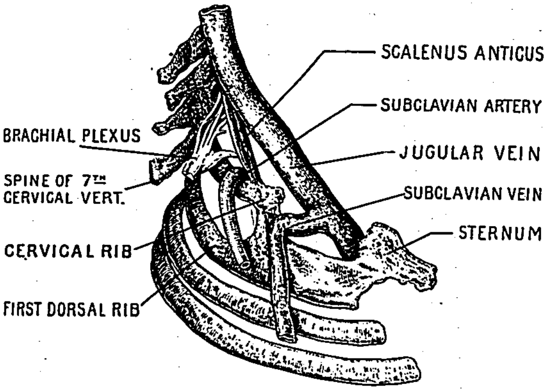

FIG. 9.—Rib and soft parts in the case of Weissenstein. Note the angle of the cervical rib, the sharp bend of the subclavian artery behind the scalenus anticus, and the position of the vein and the plexus.

When cervical ribs are developed on both sides not only is one almost always more highly developed than the other, but one is apt to be at a higher level than the other (Fig. 11). The symptoms then arise on the side of the larger and the more highly placed rib.

The most important relations of a cervical rib are to the artery, the vein, the brachial plexus, the muscles, and the pleura.

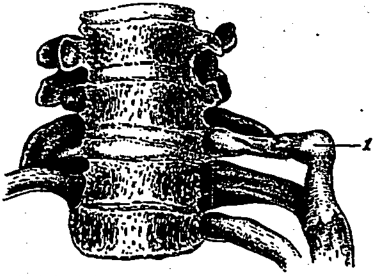

FIG. 10.—Sketch of the rib in the case of Ehrich-Madelung, showing the angular shape of the rib, its articulations, and the knob (1) at the angle.

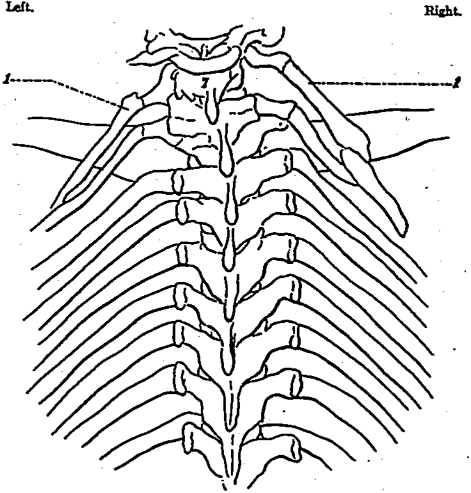

FIG. 11.—1, 1, cervical ribs. 7. Seventh cervical vertebra. Note how much higher the right cervical rib is than the left. Symptoms existed only on the right side. (Gordon, Brit. Med. Jour., June 8, 1901, 1395.)

The Artery. If the cervical rib is short or of only moderate development the plexus and the vessels do not pass over the rib, but in front of its anterior end. The rule promulgated by Halbertsma (that when the length of the rib is under 5.1 cm. the artery passes in front of and not over it, but when the length is 5.6 cm. or more the artery passes over it) does not literally hold good, but within certain limits it gives a very fair idea of what generally occurs. Gruber, Aron, and Brodier have reported cases in which the rib was 5.6, 5.75, and even 7 cm. long, yet the artery did not pass over the rib. The artery never runs under the cervical rib. When the rib is of considerable length so that the artery and nerves pass over it, the chest cavity is lengthened by the addition of this rib; hence, the artery is no longer than normal, rises much higher in the neck than normal, and after it crosses the extra rib, passes downward at a much more acute angle than usual. Ordinarily in order to compress the subclavian artery it is necessary to insert the thumb or finger well behind and beneath the clavicle, but as will be observed by looking at Fig. 1, in my own case, in which I outlined the length, diameter, and direction of the subclavian, it will be seen how far above the clavicle the artery passes and how oblique is its course. This photograph emphasizes the accessibility of the artery for compression in cases of aneurysm.

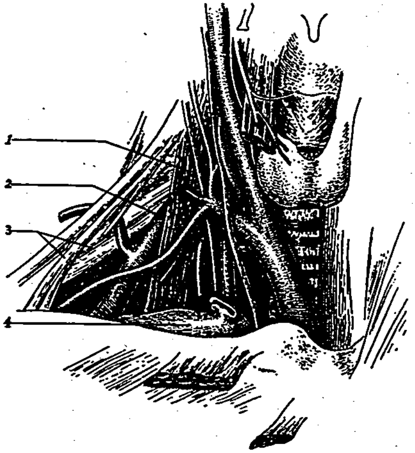

FIG. 12.—Showing that the subclavian artery may rise abnormally high in the neck, even when there is no cervical rib. Note also the position of the vein (Quain). 1. Scalenus anticus. 2. Subclavian artery. 3. Brachial plexus. 4. Subclavian vein.

But it must be remembered that even when there is no cervical rib the subclavian artery may pass high up in the neck. Thus, in the cases of "C. L." and "C. F. M." (*vide infra*) the artery rose 3.5 cm. above the clavicle. Quain (*Anatomy of the Arteries*, Plate XX, Fig. 3) also gives a case (Fig. 12) in which the same high position of the artery was shown by actual dissection, yet there was no cervical rib present.

The Vein. As a rule this is at a considerable distance in front of and below the artery. This is well shown in Fig. 12, and also in Fig. 13, from one of Broadbent's cases. This position of the vein, and, as insisted upon by Murphy, its not being compressed between the cervical rib and the scalenus anticus, since it lies in front of this muscle, account for the absence of œdema in the arm in nearly all cases.

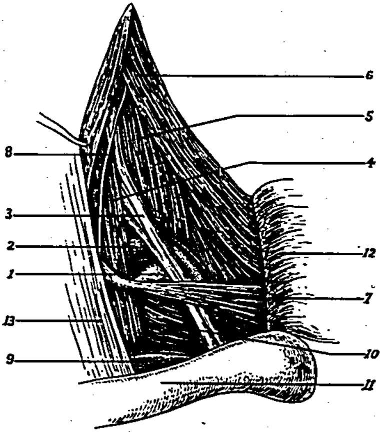

FIG. 13.—Showing especially the relation of the vein. 1. Cervical rib. 2. Subclavian artery. 3. Brachial plexus. 4. Scalenus anticus. 5. Scalenus medius. 6. Levator anguli scapuli. 7. Omohyoid. 8. Phrenic nerve. 9. Subclavian vein. (Broadbent, Brit. Med. Jour., May 5, 1906.)

The Brachial Plexus. As the brachial plexus lies above and to the outside of the subclavian artery, whenever the artery passes over the rib, the nerves must also pass over the rib.[5]

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[5] In Murphy's papers his artist has made two errors in the figures. An aneurysm is represented in one figure on the right side, and in another on the left side. In a personal letter Dr. Murphy states that the enlarged artery was on the left side, but that there was no aneurysm. The other error is more important. In Fig. 5 of the earlier paper and Fig. 3 of the later, the artist has represented the cross-section of the rib as a vertical instead of a horizontal oval, the artery to its outside instead of above it and the plexus below the artery and on the inside of the scalenus anticus, whereas the plexus really lies to the outside of and above the artery and wholly external to the scalenus muscle.

It is very important to determine the relation of these structures to the rib during operation, so that without injuring them we may gain easy access to the bone and remove it. Commonly the plexus is best displaced upward and outward, the artery downward and inward. Rarely will the vein require any attention, as it is not in the way. Indeed, often it is not even seen.

The Muscles. When the rib is developed to any considerable extent there is present an intercostal muscle, usually the external only. The scalenus anticus is often inserted into the anterior extremity of the cervical rib. *This is a clear evidence of the congenital origin of the anomaly.* The medius and posticus may either escape insertion into the cervical rib or be inserted into this rib alone, or they may be inserted into the cervical and the first and second dorsal ribs. Occasionally (Fig. 14) the artery and nerve penetrate through the scalenus medius, dividing it into separate fasciculi. The importance of the muscular relation of the artery will be seen later.

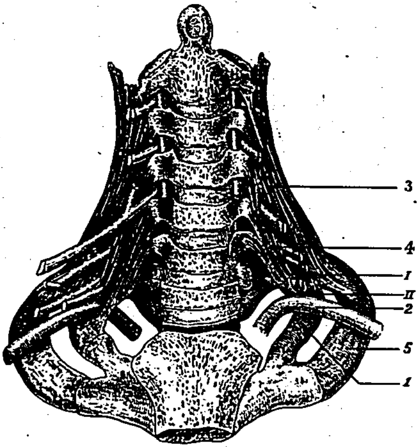


Fig. 14.—Showing division of the scalenus anticus into bundles by the artery and the nerves on both sides (Pilling). 1. Cervical rib. 2. Subclavian artery, which here shows in *front* of the scalenus anticus instead of behind it. 3. Scalenus medius. 4. Scalenus anticus, divided by the artery and the nerves into bundles. 5. First dorsal rib. I and II. Two bundles of the scalenus anticus on the left side; on the right side it is divided into three bundles. The artery could be compressed by the scalenus anticus on the right side, but not on the left. The roots of the brachial plexus are numbered 5, 6, 7, and 8.

The Pleura. The pleura rises much higher in the neck in cases of cervical rib than in the normal neck (Fig. 15). Its arched dome is often so closely adherent to the rib that it is very difficult and sometimes impossible to separate them without tearing the pleura. In other cases, as in my own, it is so easily detached that it may not even be seen. Its proximity must always be borne in mind and great caution exercised when dissecting the rib on its under surface.

SYMPTOMS. The symptoms may be grouped under four headings: (I) Local symptoms in the neck; (II) the nervous symptoms; (III) the vascular symptoms; and (IV) the muscular symptoms.

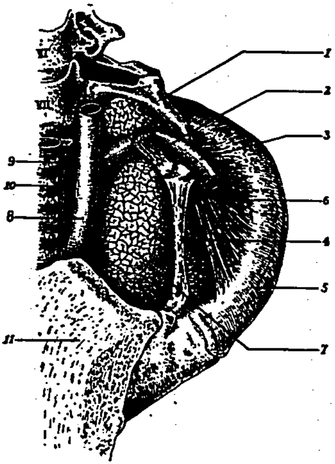


FIG. 15.—Showing a rudimentary rib (1) with its knobbed end, to which is attached the scalenus anticus (2). The rib is prolonged to the sternum by a ligamentous cord (4). Note *the relation of the pleura and lung* (7) *to the cervical rib.* 3. Subclavian artery. 5. First dorsal rib. 6. Intercostal muscle between the cervical and the first dorsal rib. 8. Left carotid artery. 9. Œsophagus. 10. Trachea. 11. Sternum. (Luschka.)

I. *Local Symptoms.* There is usually a tumor in the neck. This may be either palpable, or visible, and frequently is perceptible to touch and sight. The site of the tumor is usually about one to two fingers' breadth above the middle of the clavicle. It is usually more or less rounded, hard, more frequently immovable, but sometimes, when there is an articulation at each end, slightly movable. It can be traced back toward or even to the seventh cervical vertebra. In addition to this, above the tumor, and, therefore, relatively high up in the neck and running obliquely from above downward and outward, there is a visible and palpable pulsation. A high and oblique pulsating vessel, if observed, should always arouse the suspicion of a cervical rib. The cause of this pulsation is the displaced subclavian artery. There may be a bruit, which, however, is not often propagated; rarely will there be a thrill. The pulsation is sometimes expansile, but more commonly it is not. Just above and to the outside of this pulsating vessel there is tenderness, and in very thin patients the seat of this tenderness, namely, the brachial plexus, is palpable. On the other hand, palpation is, in my opinion, a very misleading, and by no means reliable, method of examination. Dr. Patrick, of Chicago, in communicating to me the history of his first case (the first one, I believe, diagnosticated and operated on in Chicago) has also made the same observation. The diagnosis reached by palpation should always be confirmed, or, as is sometimes the case, refuted by a good skiagraph. If the rib is very small, it may easily escape attention even on a careful physical examination.

As illustrations of the impossibility of absolutely determining by palpation the existence of a cervical rib, I mention the following cases seen by myself:

Supposed Cervical Rib, there being no Pulse up to and including the Axillary Artery on both sides and later none in the Subclavian. A skiagraph showed no such Rib.

C. F. L., aged twenty-three years, was first seen December 9, 1905, with Dr. T. D. Taggart.

Dr. Taggart recently had percussed her chest and neck and then accidentally discovered, as he believed, that she had bilateral cervical ribs. Up to that time she had no knowledge that there was any trouble in her neck. She has had absolutely no symptoms either of pain or discomfort.

On examination I found what I too thought was a cervical rib on both sides, which could be traced back to the spinal column. The subclavian artery on the right side was 3.5 cm. and on the left 3 cm. above the clavicle. It pulsated normally. Below the subclavian, in the axilla, arm, and forearm, no pulse whatever could be discovered on either side. The resonance of the lung in the neck extended up to the level of the cervical rib.

January 9, 1906. Examination of an *x*-ray picture shows no cervical rib on either side (Fig. 16). Re-examination of the patient showed a hard supraclavicular tumor on the left side with a smaller similar one upon the right. This probably is the first dorsal rib more highly placed than usual. I could not now detect, on either side, pulsation either in the subclavian itself or in any artery below that in either arm, yet the circulation was not affected, the skin was not blue, the white spots caused by pressure disappeared as quickly as usual, and in every way the arm seemed to be normal.

October 26, 1906. The same conditions as noticed in January still exist.

Partially Developed First Dorsal Rib Mistaken for a Cervical Rib. A Bruit, but no Perceptible Thrill in the Subclavian Artery.

C. F. M., aged twenty-one years, telegraph operator, was first seen January 30, 1906. About eight years ago he noticed an enlargement on the left side of the base of the neck. No other symptoms appeared until four months ago. Since then he has had a sensation of numbness in the left arm. It sometimes extends downward and involves the flexor surface of the forearm. During the past four months he thinks that the mass he observed has increased in size.

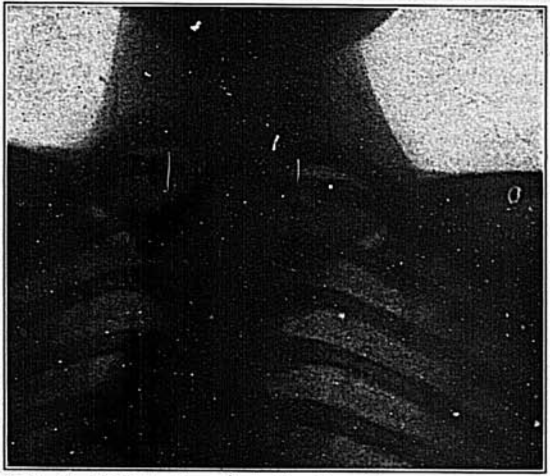


FIG. 16.—Case of C. F. L. Supposed cervical rib. Skiagraph shows none, yet there is a hard tumor in the neck and no pulse in either arm from and including the subclavian. (Keen.)

On examination the left side shows a fulness and the subclavian artery can be seen pulsating directly under the skin. Careful palpation shows that the subclavian artery appears in the neck at a point 3.5 cm. above the upper border of the clavicle and runs downward and outward, disappearing behind the clavicle. Palpation also shows behind and below the artery a hard, immovable mass which I believed to be a cervical rib. It could be traced backward to the spinal column and forward to the clavicle, behind which it was lost. At this time I did not make a careful examination of the first rib at the normal point for its attachment to the sternum. No thrill could be observed in the artery, but there was a distinct bruit observed by the stethoscope. Evidently the artery passed over the first rib. Its diameter also seemed to be increased. The pulsation in the two arms was normal. The right side of the neck showed no such prominent hard mass, no pulsation was visible, no bruit, and the subclavian artery ran behind the clavicle at its usual level.

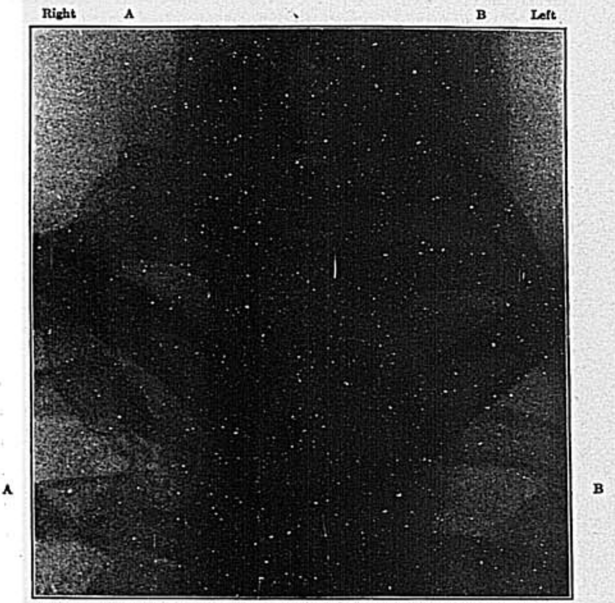


Fig. 17.—Partially developed first dorsal rib on the left side mistaken for a cervical rib. (See text.) (Keen.)

Dr. J. C. Da Costa, Jr.. kindly examined his blood pressure and found a systolic blood pressure in the normal position of the left arm, of 132 mm. With the patient sitting upright and the arm raised above his head it was 125 mm.

I directed that a skiagraph should be taken. On examination a very unusual anomaly of the first rib was observed.

The supposition that the patient had a cervical rib was proved by the skiagraph to be incorrect. On the right side (Fig. 17) the first rib is very clearly seen and at the point where the two lines A A would cross, the cartilage of the first rib is seen to be mottled, as though it were undergoing ossification, although the patient was only twenty-one years of age. On the left side is a still more peculiar condition. The first rib, instead of curving forward from the spine, as does the right, changes its direction at its articulation with the transverse process and thence runs almost in a straight line downward and outward. The tip of it is lost at the point where the first rib and the clavicle cross each other. From that point to the sternum there is no rib, but on the sternum, at the point where the two lines B B would meet, is a conical projection from the sternum just below the end of the clavicle. This represents the point at which the first rib would have articulated had it reached the sternum.

When I first examined the patient I felt certain that he had a cervical rib on each side and I was only undeceived by the skiagraph. Palpation seemed clearly to indicate a cervical rib.

II. *Nervous Symptoms.* The nervous symptoms are considerably more frequent than the vascular. About two-thirds of the patients complain of pain and other nervous symptoms, whereas only about one-half suffer from vascular troubles. Commonly the very first symptom is pain, shooting or neuralgic in character, starting usually in the neck and radiating down the arm sometimes as far as the elbow, sometimes all the way to the hand; more commonly on the ulnar than the radial side of the forearm. Sometimes the pain radiates to the head; sometimes to the chest. It often begins in one or more fingers and gradually spreads to the other fingers and then extends up the arm. Muscular exertion, especially hard work, is likely to increase the pain, or sometimes is thought to have caused it. It is sometimes worse in winter than in summer.

Again, the involvement of the nerves is shown by diminished or perverted sensation. The cases in which the sensory phenomena have been the most carefully observed, are that of Dr. Lewellys F. Barker in his own person, and by Bernhard. In one of Dr. Patrick's cases (No. 32), he has kindly allowed me to copy his drawings, showing the disturbance of sensation (Figs. 22 to 25), as have also Mr. Sargent and Dr. Buzzard (Fig. 27). In Patrick's case (No. 32) the anesthesia was so marked that an accidental burn of the forearm was felt but little.

The paresthesia is frequently described as the sensation of pins and needles, formication, tingling, numbness, or "going to sleep." The area usually corresponds with the portion of the arm supplied by the lower cords of the brachial plexus. Moreover, there is either diminution, or, in some cases, entire absence of electrical reaction and in advanced cases the reaction of degeneration is shown. In one case (No. 5) there seems to have been a distinct neuritis, so that when the elbow had been extended to 150° it was impossible to extend it farther on account of the pain.

In Hauswirth's case, handling of the extremity produced such pain that it had to be conducted with the greatest gentleness or even abandoned.

The sympathetic nerve apparently has been involved in four cases. Müller's case showed typical paralysis of the right cervical sympathetic. In Hirsch's case there was profuse sweating and coldness on one side, and dryness of the skin on the other. Gordon attributes the rapidity of the pulse in his case to irritation of the sympathetic. In Schönebeck's case (No. 61 in his series) a patient with bilateral symptoms, the left pupil as well as the left palpebral fissure was larger than the right, and there was facial asymmetry. But in this case the cervical rib was associated with syringomyelia.

Hoarseness. In a few cases (Nos. 2, 6, 16, and 19) there has been hoarseness. This is probably due to some actual affection of the throat and not to involvement of the recurrent laryngeal, which is far removed from the possibility of pressure. In only one case, Borchardt (No. 19), has a laryngeal examination been made. This showed that the right vocal chord was paralyzed. This patient suffered also from syringomyelia.

III. *Vascular Symptoms.* I have already alluded to the marked pulsation in the neck. In Ehrich's case (No. 4), on the contrary, pulsation even in the subclavian was entirely absent and the artery felt like a hard cord, owing presumably to a thrombus in the vessel. In very many cases this is probably due to distal blocking of the vessel. On the other hand, aneurysm has been asserted to exist in a number of cases. (*Vide infra.*)

In a considerable number of patients the pulse at the wrist has been entirely absent and not uncommonly it has been absent also in the forearm, the arm, and the axilla. This, doubtless, is due to a thrombus. As a result of the ischemia the hand and often the arm become cold and blue, or more frequently blanched, sometimes even suggesting possible Raynaud's disease. The blood returns very slowly to the part after brief pressure on the tissues. Generally, even after operation has removed the obstruction to the circulation, the pulse fails to return and the obstruction is permanent. In Babcock's case, and partially in my own, the pulse returned after operation, but this is very rare. Yet the collateral circulation usually is partly established so that gangrene (*vide infra*) is unusual. The thrombus is apt to extend somewhat slowly upward to the subclavian, and even that vessel may be involved. I know of no case in which it has progressed beyond this point. In the case of C. L. F. (*vide supra*) it finally involved the subclavian on both sides, but without apparent injury to the vitality of the arms. In this case there was no cervical rib.

Gangrene. In the cases of Babcock, Gordon, and my own in my table, and in those of Cooper, Hodgson, and Gould, owing to the arrest of the circulation, gangrene of the tips of the fingers has followed. Grisson's case was on the verge of gangrene. But in other cases, even when the pulse has been obliterated as high as the brachial and even the subclavian, the re-established circulation has prevented this misfortune. The gangrene has never extended in any case that I have found beyond the first phalanx, and usually is limited to the tips. After operation, or without it, the parts gradually mummify, drop off, and the resulting ulcer heals. It is worthy of note, that of these seven cases two of the six, in which the age is stated, occurred in patients nineteen and twenty-two years of age; the others ranged from thirty-two to sixty-three years.

The effect on the pulse of varying the posture of the arm has been quite marked in a number of cases. On raising the arm the pulse returned, and in addition to this, apparently from the relief of pressure, the pain would diminish. Sometimes a deep inspiration by raising the rib in the neck would produce marked influence upon the volume of the pulse, and in one unique case (No. 4), at the height of inspiration, the pulse disappeared entirely.

Œdema is exceedingly rare. Like Murphy, who says "that in looking over the clinical records of these cases, he was struck by the absence of œdema as a symptom," I, too, have been much impressed with its absence. Yet there are four cases in which there seems to have been a possible partial involvement of the vein. In Gordon's case, two months after the onset of the symptoms, there was swelling of the hand, but no pitting on pressure. The artery was obliterated from the middle of the arm down and gangrene followed. In Hauswirth's case, he expressly states that "the hand and forearm were swollen, blue, and cold;" and Berg, at the operation on his case, found "the veins of the suprascapular and transverse cervical systems considerably enlarged and required double deligation." In the case of de Quervain, before he saw his patient, a soldier, the physician calling for him noted that there was some swelling and redness of the skin. When de Quervain saw him about four months later, he said that on the affected side "the veins of the back of the hand were fuller than upon the other side." In Thorburn's patient, the hand was cold, and there was a very slight œdema "which may have been due to pressure upon the subclavian vein."

In none of these cases is pressure upon the vein more than suspected, and I think it extremely doubtful whether the swelling or the slight œdema had any relation to the subclavian vein.

Murphy explains this absence of œdema "by the fact that the scalenus anticus is attached to the first rib and lies between the artery and vein so that the latter, situated in front of the muscle, has nothing to hold it firm for counterpressure." When the scalenus anticus is attached to the cervical rib, the vein lies in front of the muscle and the artery behind it.

Aneurysm. In ten cases (Poland, Adams, Stiffler, Murphy, Ehrich (Karg), Fischer, Braun, Pancoast, Grisson, and Conner), and a few other more doubtful cases, the symptoms suggested an aneurysm. None was found, at operation, in Pancoast's case, and only flattening of the artery in Murphy's. Conner says that the pulsation "suggested aneurysm." There is no question that at operation the artery has been found enlarged by some observers (Ehrich, Murphy, Keen) (Fig. 4), and at the necropsy in Adams' case a cylindrical aneurysm was actually found extending from the outer border of the scalenus anticus to the brachial.

But the curious fact is that in these cases, as in my own and others, the dilatation of the vessel was external or *distal* to the point where the artery passed over the cervical rib and distal to the point where it passed behind the scalenus anticus muscle. It is difficult to account for the dilatation distal to the point of pressure or constriction. Possibly it may be due to resistance caused by the still more distal blocking of the artery.

Murphy has made a special point that in the inspiratory movements of the thorax the artery is caught between the rib and the scalenus anticus, and he thus explains the aneurysm.

Even granting, as is probable, that the artery is pinched between the muscle and the bone at this point, this obstacle to the circulation should produce a dilatation *proximal* to the point of constriction and not distal, just as in the case of obstruction of the intestines from a band the bowel is distended proximal to the band and shrunken on the farther side. The observation in my own case was very carefully made and I am absolutely positive of the small caliber up to the point at which the artery emerged from behind the scalenus anticus, and its caliber was nearly doubled from there down to the level of the clavicle. In Murphy's case (No. 31) the artist has represented what, at first sight, seems to be an aneurysm of large size distal to the scalenus. Dr. Murphy's text describing the case shows that there was no aneurysm, but that the artery "was somewhat enlarged" and in five weeks "had contracted to its usual size." The illustration, Dr. Murphy informs me, was intended to show only flattening of the artery. In Poland's and Fischer's cases compression produced early consolidation in the artery and resulted in cure and a return to work.

Usually the pulsation is visible as well as palpable and is very marked. It is occasionally noted that it was "expansile." Bruit or thrill, one or both, are often present, the latter less frequently than the former. The bruit, however, is not propagated. Neither the thrill nor the bruit seem usually to be of the true aneurysmal character. Moreover, the "aneurysm" rarely increases in size or symptoms. Under pressure, or more often without any treatment, it either remains as before, or lessens, and may disappear. In no case has the vessel been ligated; a very wise abstinence.

Another curious case is that of Ehrich (No. 4), in which though at operation the walls of the artery are described as apparently sound the aneurysm developed *after* operation. This may have been due to the loss of support of the bone and other tissues around the artery and to the injury to the walls of the artery by the constant respiratory compression between the two ribs.

On the whole, the evidence of true aneurysm in most of the cases in which it has been reported, are, to my mind, by no means always convincing. Usually the diagnosis has been based on the strong pulsation, sometimes with bruit and thrill. In a few cases, as in my own, the artery has been found, at operation, moderately enlarged, or in one case (Murphy's) flattened. In several cases operation has, therefore, disproved the presence of the supposed aneurysm. The postmortem in Adams' case disclosed a cylindrical aneurysm. Bearing upon the history of pressure or tension of the artery as it crosses the cervical rib, it is significant in Fischer's (Braun's) case that when the arm hung *down* (pressure or tension) bruit was present, and when it was held up (relief of pressure) the bruit disappeared.

That these aneurysms should have undergone spontaneous cure without treatment, other than bandaging and pressure, or removal of the rib, is certainly sufficient to make one suspicious of there ever having been a true aneurysm, except in a very few cases.

In a letter to Prof. Turner, Paget very suggestively says: "In each case the imitation of aneurysm was close enough to deceive an unwary surgeon; but to one who examines closely, and has in his mind what the case may be, the mistake seems scarcely possible, so long as the artery is healthy."

Thrombosis. Allied to the question of aneurysm is that of thrombosis. Here we are on much firmer ground; for that there is a constriction of the artery and an interference with the blood current which might be followed by coagulation there is no doubt. Thrombosis has been recorded by Hodgson, Cooper, Adams, Coote, Braun, (Fischer), Ehrich (Madelung), Gordon, Keen, Fischer, and Grisson.

The extent of the thrombosis varies somewhat, but may involve the arteries of the forearm, not uncommonly of the arm, the axillary, and even the subclavian. Occasionally the progress of the thrombosis has been followed almost day by day, from wrist to axilla. Pulsation in the artery is then, of course, absent and the artery itself is felt as a hard solid cord. After removal of the rib, it is rare for the pulsation to return (Babcock, Keen). The collateral circulation, as would naturally be expected, is established after a time, but is often so imperfect that the skin is very cold and white or blue; and after pressure the color due to the restored circulation returns very slowly. Gangrene of the finger-tips has been considered.

IV. *Muscular Symptoms.* The muscles of the arm on the affected side usually undergo gradual wasting, so that the circumference of the arm and forearm will be from 1 cm. to 4 cm. less than the opposite one. This wasting is especially marked in the thenar and hypothenar muscles, not uncommonly also in the interossei; often the muscles of the forearm are involved. Occasionally the loss of power extends to the muscles of the shoulder and the chest. Along with this there is markedly lessened usefulness of the arm and especially of the hand in the more delicate movements required in sewing, writing, etc. The arm becomes easily tired and the fingers stiff. If the work is at all severe it has to be given up. It will be noticed that the muscles as well as the sensory area involved point to the lower cords of the brachial plexus and not to the upper.

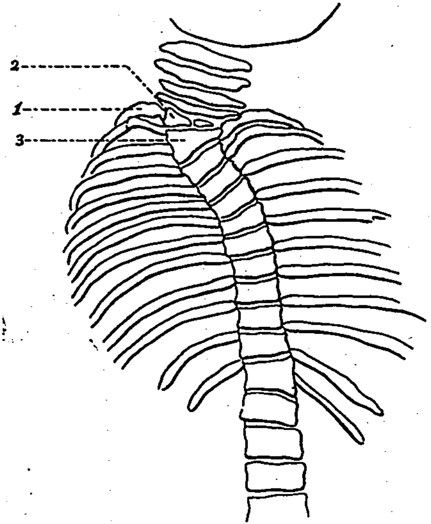


FIG. 18.—Scoliosis with cervical rib; child, aged eighteen months. Note 1, cervical rib attached to one portion of 2, the intercalated body of a cervical vertebra in two pieces. 3. Wedge-shaped body of the first dorsal vertebra bearing two ribs. (Drehmann, Fig. 2.)

Dysphagia. In the cases of Bernhardt, Ranzi, and Tilmann, dysphagia was also noticed. This, most likely, was hysterical, since there is no evidence of there being any direct pressure or interference with the function of the œsophagus. Yet this symptom was so severe in a case seen by Kiliani as to suggest even cancer of the œsophagus. Both he and Lilienthal agreed that it was due to muscular spasm.

Scoliosis. In Schönebeck's sixty-one collected cases (1905) scoliosis existed in twenty-two. In several of the cases operated upon, scoliosis is also recorded. This, of course, is of special interest to the orthopedic surgeon. The convexity is usually toward the side of the cervical rib, or if a rib is developed on both sides, the convexity is toward the side of the larger rib. The deflection extends from about the fifth cervical to the fourth dorsal vertebra. It usually is attended also with a high scapula on the convex side.

In 1902, Garrè called attention to scoliosis in connection with cervical rib. Before this Drehmann had reported four such cases, but had not at that time the advantage of the investigation by the *x*-rays.

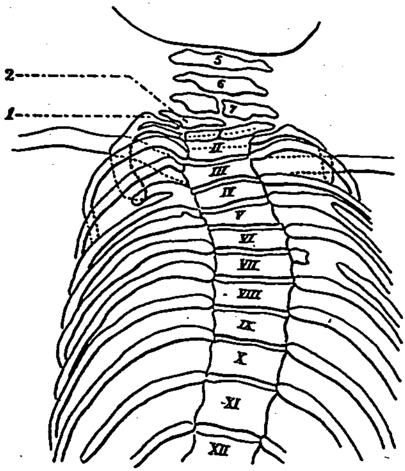


FIG. 19.—Scoliosis with cervical rib. Boy, aged twelve years. Note 7, the body of the seventh cervical vertebra in two pieces. Between it and I the first dorsal vertebra is 2, an intercalated fragmentary body of a vertebra carrying 1, a rudimentary cervical rib, which quickly fuses with the first dorsal rib. Note also several other abnormalities of the ribs on both sides. (Drehmann, Fig 6.)

In 1906, at the Congress of the German Orthopedic Association, Drehmann returned anew to this subject and presented the most important paper on this form of scoliosis which has yet appeared. Moreover, the article is illustrated with reproductions of skiagraphs of his cases, and what is most useful, outline sketches indicating what may be seen in the skiagraphs. It requires a little imagination, I confess, to identify all the parts of the outline drawings in the skiagraphs, but enough is seen to convince one that in all probability the sketches are faithful to what is seen in the originals, which, of course, are very much clearer than the reproductions, excellent as they are.

In one child, aged eighteen months, with wryneck, but without rickets, the skiagraph showed (Fig. 18) a marked scoliosis in the cervicodorsal region. "On the convex side there is a fully developed cervical rib which stands in relation with a supernumerary vertebra. This vertebra is divided into two parts: a large wedge-shaped portion, which carries the rib, and a small rudiment on the concave side. On the convex side of the scoliosis the first dorsal vertebra carries two ribs. It is made up of two parts; the upper piece corresponds to the normal vertebra, under which is placed also a wedge-shaped vertebra, which also carries a rib." It will be observed also that on the right side the twelfth vertebra carries two ribs.

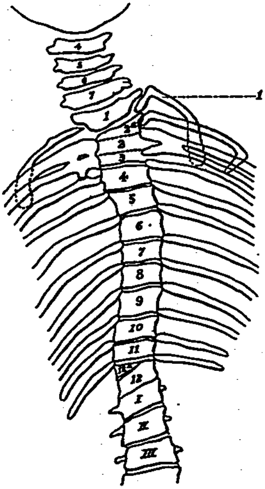


FIG. 20.—Scoliosis with cervical ribs. Girl, aged fourteen years. Between the bodies of the first and second dorsal vertebræ is a wedge-shaped supernumerary body, 2a, fused with the bodies of the second and third dorsal vertebræ. This rudiment carries a cervical rib, 1. Several other anomalies of the ribs and the vertebral bodies are to be seen. (Drehmann, Fig. 8.)

In another case, a boy, aged twelve years, the skiagraph shows "A division of the seventh cervical vertebra, and between it and the first dorsal vertebra a wedge-shaped vertebral rudiment is intercalated, which on the convex side carries a cervical rib. This cervical rib unites with the first rib (Fig. 19). The first and second dorsal vertebræ cannot be differentiated. They seem to be blended with each other. The fourth rib on this side is also rudimentary. On the opposite side the fourth rib bifurcates, and it seems as if on both sides the fourth and fifth ribs are united. The seventh rib also shows a defect on the right side."

Another case (Fig. 20) shows several anomalies in the ribs and the vertebral bodies, as noted in the legend.

Several of his figures also show some remarkable deviations from the normal in the lumbar vertebræ, as well as in the cervicodorsal.

He calls attention to the fact that up to the present time congenital scoliosis has been held as an extreme rarity. He believes this to be an error and urges methodical examination by the x-rays.

The cases he describes are divided into two classes: the first group are those in which the supernumerary rib belongs to a corresponding rudimentary intercalated vertebra; the second group, those cases in which a true cervical rib exists, without any intercalated vertebral fragment.

As to treatment, he believes that extirpation of the supernumerary rib in these cases is entirely useless, since they ought not to produce any pressure symptoms on the plexus.

Cause of the Symptoms. Borchardt believes that only about 5 to 10 per cent. of the cases of a cervical rib are followed by any symptoms. Whether this is at all an accurate percentage is rather unimportant; it is certain that the vast majority of cases, in which this anomaly exists, have no symptoms whatever which can be attributed to the presence of the rib. There must be, therefore, something exceptional in the cases which show symptoms different from the majority. I am inclined to believe that in Laplace's case the symptoms were due to the severe trauma to the shoulder and not to the presence of the cervical rib.

Injury. In a certain number of cases there can be no question that injury, direct or indirect, is responsible for awakening the symptoms. Thus, in cases Nos. 2, 23, and 33 the patient had a fall. In Poland's case the drawing of a cork was attended with a feeling as if something had been torn loose in the neck. In Stiffler's case, lifting of the arm was attended with a feeling of a tear in the neck and was assigned as the cause of the resulting aneurysm. In three cases (Nos. 4, 7, and 15) pressure of the rifle at "shoulder arms" or the pressure of the straps of the knapsack were clearly the cause of the trouble, and Brewer's patient was a peddler. Other occupations, such as that of a seamstress, sewing base-balls, paring potatoes for two hours (Marburg), writing, piano playing, etc., seem to have had a definite influence.

In consequence of the protrusion of the end of the rib, there is more danger of injury than where the parts are normal. In

Williams', Borchardt's (No. 18), and Starr's cases, even so slight a constant but repeated injury as the pressure of the collar seems pretty clearly to have evoked the earliest symptoms.

Ill Health. It is to be noted that in a very considerable proportion of the patients ill health preceded the first symptom. Repeatedly, anemia, chlorosis, general ill health, or some debilitating disease is noted. This may have been a factor in arousing the trouble by the wasting of the fatty tissues in the neck itself besides its general predisposing influence. In Borchardt's case (No. 20) diphtheria seemed to be the cause of the trouble; possibly by the direct toxic effect.

Pressure, Constriction, and Sharp Bending of the Artery. Pressure and constriction of the artery may arise in two ways. I have already alluded to the view that Murphy has particularly advocated that there is marked compression of the artery in the angle between the rib and the scalenus anticus. That this is true I think there is no doubt. In Weissenstein's case, dissection shows excellently how this is brought about (Fig. 9; see also Fig. 4). Halbertsma and Luschka have advocated the view that the trouble is due to direct pressure of the rib on the artery, especially in inspiratory movements in which the cervical rib would lift the artery by muscular effort. At the rate of sixteen inspirations in the minute, an upward excursion of the rib occurs nearly 1000 times in an hour and about 23,000 times in a day. If continued day after day for years, even this slight upward pressure in lifting the artery might easily produce such an obstacle to the circulation and such a possible effect upon the arterial walls as to be followed by a diminution in the volume and force of the pulse and not uncommonly by thrombosis. Gruber believes that there can be no such tension of the artery from upward pressure, and Sue insists that if the cage of the chest is developed vertically to a greater extent than is normal the arteries would also develop *pari passu* in length. This view of co-ordinate development of the chest and the bloodvessels seems very plausible, especially in view of the fact that only a small percentage of cases, in which cervical rib exists, do show any symptoms. But to my mind, the argument that pressure and its results really exist in the cases with symptoms is valid for the following reasons:

1. As a matter of fact, at operation a sharp bend in the artery has been especially noted by Ranzi and was marked in my own case. In Borchardt's case (No. 18) traction on the hand downward was seen to cause complete compression of the artery between the scalenus and the rib, and in de Quervain's case, certain movements of the shoulder compressed the artery between the rib and the clavicle.

2. In a number of cases the moment that the rib has been removed the artery has sunk down into the soft tissues of the neck, showing the relief of tension, and the symptoms have quickly disappeared.

3. Murphy writes me that in his first case (No. 31) the artery was *flattened.*

4. In Kammerer's case, the pulse completely disappeared on deep inspiration and in others it was weakened.

5. It should also be pointed out that the argument has been applied only to the artery. The nervous symptoms, due to the lesion of the brachial plexus, are much more frequent than the circulatory symptoms. As to the nerves, the argument of Sue entirely fails, because the brachial plexus arises in the neck *above* the level of the cervical rib and the course of the plexus is from above downward and outward. Angulation cannot then be assigned as the cause, as in the case of the artery; but the upward pressure of a longer cage of the thorax certainly exists and this upward pressure is constantly repeated, as in the case of the artery at every inspiration. Coote, in the first case ever operated on, expressly states that "the nerves were *flattened* upon the upper surface of the rib." Warren notes that the brachial plexus "had been somewhat *stretched* by the arched position of the bone." Removal of the bone relaxed the plexus. In my own case the same phenomena were observed. In Thomas and Cushing's case direct "compression" of the lower cord of the plexus "by a dense fibrous band which passed from the tip of the rudimentary rib under the plexus to its point of attachment on the first thoracic rib" was found. This band represented the continuation forward of the imperfectly developed cervical rib.

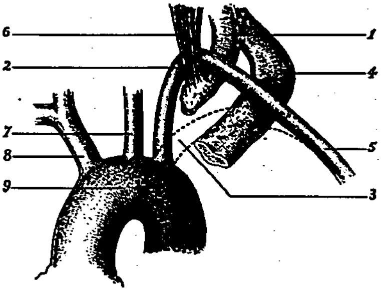


FIG. 21.—Scheme to show the changed course and the consequent angulation of the subclavian artery when it passes over a cervical rib. The dotted line (3) represents the normal gentle curve of the artery. 1. Cervical rib. 2. Subclavian artery passing over the cervical rib. Note its high position, its angulation, and the likelihood of pressure by the scalenus anticus 6. 4. First dorsal rib. 5. Axillary artery. 7. Left carotid. 8. Innominate. 9. Aortic arch.

6. Moreover, as in the case of the artery, the removal of the offend-

ing rib almost always has been followed by sinking downward of the plexus and relief of the nervous symptoms.

7. Again, the *lower cords* of the plexus are much more frequently involved than the upper. This is consonant with the theory that it is the upward pressure of the cervical rib lifting the lower, rather than the more distant upper cords which produces the lesion. Naturally, the upper cords would be the most likely to escape. The artery would not show this so well, since its walls are elastic and its contents fluid.

Angulation. The subclavian artery, arising either on the left side, directly from the aorta, or on the right side, from the innominate as it passes outward in a gentle curve to the axilla, rises normally into the neck a little above the upper border of the clavicle. In Fig. 21 the dotted line shows its normal course. In cases of cervical rib the artery usually rises in the neck from 3.5 to 5 cm. or more above the level of the clavicle and must bend acutely downward and outward to reach the axilla, as shown in Fig. 21. This shows the difference between the normal course of the subclavian artery and by contrast its course when it runs over a cervical rib. It shows also the *necessary* sharp bend or angulation in the artery when a cervical rib is present. See also Figs. 9, 12, 13, 14. and 15. In almost every case it is noted that the pulsation of the subclavian artery was felt or seen, or both, far above the level of the clavicle, instead of being just behind that bone or barely above its level. This sharp bend or angulation of the artery, in addition to tension or pressure, I believe to be of considerable influence in producing the vascular symptoms.

How can we Account for the late Appearance of the Symptoms? The age at which symptoms have been noticed in the 42 cases operated on was as follows: Under fifteen, 6, that is, at seven, nine, ten, twelve, thirteen, and fourteen years; fifteen to twenty, 15; twenty-one to thirty, 8; thirty-one to forty, 11; sixty-two, 1; not stated, 1.

It will be seen that in a large majority of the cases the symptoms do not arise until after fifteen years of age, and in some comparatively late in life. Murphy is disposed to ascribe the outbreak at puberty or later to the growth of the rib occurring chiefly between the cartilage of the anterior end and the bone. Naturally, with growth in size from childhood to adult life, all the bones grow in length, and a cervical rib would be no exception. It seems to me that in the cases in which the symptoms appear late in life, as in my own case at sixty-two years of age, and Rutkowski's at fifty-nine, and others not in my table about the same age, this is not due to any one but to a number of factors. For example, arteriosclerosis would have some influence as the arteries begin to lose their elasticity, and if they are subject to any unusual pressure between a cervical rib and the scalenus anticus or by the repeated lifting action of the rib, changes in the wall of the vessel would be likely to occur which might easily lead to retardation and even to thrombosis. I have seen a case of senile gangrene of both feet, from calcareous arteries, at forty-five years. Moreover, as we get older, the muscles become more flabby and lose their tone, so that the shoulders sink to some extent. This would naturally increase the angulation of the artery where it passes over the cervical rib and also increase the pressure whether from the rib or from the scalenus anticus.

Again, if the rib itself is long, and especially if it reaches well forward on the first rib or even to the sternum, the space between the clavicle and the cervical rib would be much narrower than it would be in cases without a cervical rib. This may produce an increase of pressure, especially in any movements of the shoulders backward which might be involved in daily labor. In Schnitzler's case the anterior end of the abnormal rib approached so close to the clavicle that it acted as a fulcrum, so that when the shoulders were thrust backward the inner end of the clavicle was dislocated. Garrè also has called attention to bending of the clavicle at the junction of the middle and outer thirds by reason of similar pressure.

Babcock considers "that the symptoms result from the increased size or the greater fixity of the rib," and alludes to the fact that the ossification in the transverse process does not begin till puberty and is not complete till about twenty-five years. Moreover, in the head and tubercle of the normal rib ossification begins at fifteen years and is completed at about twenty-three years. "It is obvious, therefore, that a cervical rib will tend to become progressively larger, more fixed, and have greater tendency to cause pressure symptoms between the ages of fifteen and twenty-five years."

TREATMENT. The majority of cases of cervical rib require no treatment whatever. For those who are suffering pain, which is the most frequent reason leading the patient to consult the surgeon, it is right that medical treatment should first be tried and that we should not rush heedlessly to a surgical operation, unless the conditions warrant it. For example, cases in which the patient is suffering *severe* pain, or when gangrene of the tips of the fingers is either present or impending, admit of no delay. But inasmuch as there are several cases on record in which the patient has not been bettered by operation because of a concomitant progressive central nervous disease, such as syringomyelia, it would be right, if delay is possible, to test the effect of medical means until sufficient time has shown that this will do no good, or that the case is not simply one of cervical rib, but of a much graver condition of the central nervous system. These medical means are first of all rest, combined, it may be, with massage, liniments, electricity, and douches. If the patient's general health is poor, as is so often the case, of course this should be attended to and suitable hygienic and therapeutic measures should be instituted. If the case is supposed to be one of aneurysm, pressure by a pad and bandage may be applied. While remedies to quiet the nervous system and possibly hypnotics for the purpose of procuring sleep and relieving pain may be desirable in some instances, yet their prolonged use, and still more the use of opium in any of its forms, is certainly to be condemned. If the case is severe enough to require large doses of morphine with any frequency, it is severe enough to require operation.

On the other hand, delay that may permit thrombosis to occur and, especially, to progress even to gangrene, or to allow the muscles, because of the interference with their vascular or nervous supply, to atrophy and become useless, and the joints to become partially ankylosed is even more to be condemned. Each case must be judged upon its own merits and by its own symptoms and dangers.

Operative Treatment. The rapid increase in the number of operations as the condition has been more readily diagnosticated, and especially since the *x*-rays were discovered, in 1895, is remarkable. In the thirty-five years from 1861 to 1895 only eight operations are recorded. In the five years from 1896 to 1900 nine more are recorded. From 1901 to October, 1906, inclusive, that is, less than six years, twenty-five cases have been published.

The most important fact as to the whole series of operations is that the *mortality has been absolutely nil.* Not a single patient died as a result of the operation nor was a single one seriously ill, excepting those few cases in which other diseases of the nervous system, especially syringomyelia, were present. In a few the result has not been all that could be wished, but in the great majority it has been most satisfactory. In only three cases has there been recurrence, necessitating a second operation in two. In Beck's case a subperiosteal resection was followed by reproduction of a centimeter of the rib and recurrence of the symptoms. In Lilienthal's the symptoms were thought to be due to the cicatrix. No second operation was done. In Marburg's case the symptoms persisted and a second operation was done, but the persistent symptoms were probably due to the syringomyelia. In no case has a bilateral operation been required.

Operation. Three different incisions have been used: First, horizontal or nearly so, that is, parallel with the clavicle, similar to that by which we ligate the subclavian artery. Second, vertical or obliquely vertical at a suitable position and angle between the sternocleidomastoid and the trapezius muscles. Third, a combination of these two, either by an incision, one limb of which is parallel with the clavicle or nearly so, and the other more or less nearly vertical, meeting the horizontal one at the anterior end, or at some point in its course. The last one was the incision I adopted. It is, I think, a matter of indifference which of these methods is adopted. Each operator will select the one which is best, in view of the development of the rib and the depth to which the dissection must be carried. In a long thin neck the vertical incision would be the best; in a short stout neck a combined incision. When the patient's neck is of medium length and there is moderately thick subcutaneous fatty tissue a horizontal incision would very probably give sufficiently wide access. The main thing, no matter what incision is adopted, is to have plenty of "elbow-room."

Misled in his diagnosis, thinking the case one of malignant disease of the vertebræ, Brewer divided the clavicle. No harm came of it. But this is not a necessary step. In Williams' case it was considered, but rejected.

Exposure of the Tissues. Sometimes the superficial vessels in the neck are in the way either by their size or position. In these cases, whether artery or vein, they should be doubly ligated and divided. By blunt dissection we then approach the tumor formed by the rib and expose the brachial plexus and the artery. Sometimes the one or the other may not be seen. The vein is rarely seen, but its presence should always be remembered lest inadvertently it may be wounded. So, too, injury to the phrenic nerve must be carefully avoided.

The rib is now exposed by blunt dissection both anteriorly and posteriorly as far as is either possible or necessary. Very commonly if the rib is of considerable length, the scalenus anticus and very possibly the medius and posticus may be inserted into it. In such case the muscle must be separated by scissors or knife from the bone.

In isolating the rib, one of the chief dangers is the dome of the pleura. In my own case I did not see it. Although the patient was rather thin, there was sufficient fatty tissue in the neck to obscure it and it never came into the operative field. In other cases it has not only been seen, but sometimes it has been very difficult, or even impossible, to avoid injuring it. In five cases it has been torn to a greater or lesser extent (Planet, Patterson, de Quervain, Brewer, and Tilmann). In no case, however, has this proved to be a serious complication. The moment that it occurs the surgeon is aware of it by the noise of inspiration and expiration. The opening should be instantly closed by the finger and then by packing with iodoform gauze. A slight local pleurisy may follow, but in most cases only a passing trouble has resulted from this accident.

The rib is then removed as far as necessary both backward and forward, either by the chisel, the Gigli or other saw, or the bone forceps, the stump at each end being rounded off by the rongeur forceps. It is important that the stumps, especially the anterior one, whether this is the anterior end of the rib or an exostosis on the first rib, should be sufficiently removed, lest, as in Gordon's case, the subclavian is "slung" over the projection and thus still seriously interfere with the circulation. (Fig. 5 shows the stump in my own case.) In Tilmann's case it was a cause of annoying pain. If the anterior extremity is free, it facilitates removal. If the rib is attached to the first dorsal rib, and especially if this is a bony attachment, it makes its removal somewhat more difficult. In this manœuver the pleura, of course, must be very carefully protected from injury.

While it is generally recommended to remove the periosteum with the bone, this was not done in Borchardt's case (No. 11), and there was no reproduction of the rib as shown by a skiagraph four years later. Rafin also followed this method. Israel even advocates subperiosteal resection. But, as removal of the periosteum does not materially add to the difficulty of the operation, and as Beck's case showed that reproduction did actually take place and required a second operation, the periosteum should always be removed with the rib.

In uncovering and removing the rib, the brachial plexus should be drawn outward and upward and the artery downward and inward. So far as the artery is concerned, its walls are usually so strong that there is little danger of doing it injury. No surgeon capable of such an operation would probably injure the artery. There is no such instance on record. With the plexus, however, it is different. In order to uncover and remove the bone, several operators have been obliged to drag upon the plexus so seriously as to produce severe pain for several days after operation, and in some cases partial or complete paralysis of the arm (Gordon, Borchardt (No. 18), Ranzi, Marburg, and Patterson). In the great majority of cases, both the pain and the paresis or paralysis have only been temporary, but in a few cases they have been a very serious and more or less permanent sequel. It warns us, therefore, to be on our guard and to handle the plexus with as great gentleness as possible.

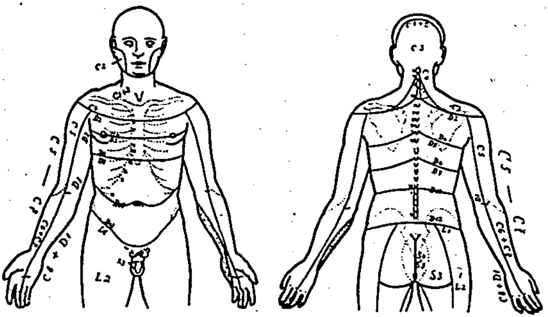
As soon as the rib is removed and the ends smoothed off the artery and plexus sink into the gap felt by the resection, and no further attention need be paid to them. The wound is closed in the usual manner, with or without drainage as may be thought desirable. de Quervain warns against drainage in case the pleura is torn on account of the possible danger of emphysema. Usually the wound is entirely healed in the course of a few days with but little if any reaction.

The after treatment should consist of massage of the arm, electricity, and passive and active movements in order to restore the usefulness of the hand and arm.

Case 32. Hugh T. Patrick and William E. Morgan (personal communication). Woman, aged twenty, no occupation, first seen September 24, 1904. Three or four days, or possibly more, before examination the left arm began to ache with an almost constant dull, "dead" pain. About eighteen months before examination she had noticed some disability of the left hand and arm. Found she would drop things, and noticed it was difficult to do up her hair.

TABLE OF 42 CASES OF CERVICAL RIB THAT HAVE BEEN OPERATED ON FROM 1861 TO THE AUTUMN OF 1906, ARRANGED IN CHRONOLOGICAL ORDER.[6]

No.	Author.	Operator.	Date.
1	Coote	Coote	1861
2	Planet	Périer	1889
3	Fischer	Fischer	1891
4	Ehrich	Karg	1891
5	Ehrich	Madelung	1894
6	Tilmann[7]	Bardeleben	1894
7	de Quervain	de Quervain	1895
8	Warren	Warren	1895
9	Czerny	Czerny	1897
10	Grounauer	Grounauer	1897
11	Borchardt	v. Bergmann's Clinic	1897
12	Williams	Williams	1897
13	Thorburn	Thorburn	1898
14	Gordon	Gordon	1899
15	Kiderlen	Schede	1899
16	Ransi	Friedlander	1899
17	Rafin	Rafin	1899
18	Borchardt	v. Bergmann's clinic	1900
19	Borchardt	v. Bergmann's clinic	1901
20	Borchardt	v. Bergmann's clinic	1901
21	Brewer	Brewer	1901
22	Israel	Israel	1901
23	Kammerer	Kammerer	1901
24	Pancoast	Frazier	1901
25	Ranzi	v. Eiselsberg	1902
26	Riddle	Riddle	1902
27	Dejerine & Armand	?	1903
28	Thomas & Cushing	Cushing	1903
29	Thorburn	Thorburn	1904
30	Marburg	v. Eiselsberg	1904
31	Murphy	Murphy	1904
32	Patrick[8]	Morgan	1904
33	Beck	Beck	1905
34	Babcock	Babcock	1905
35	Hauswirth	Berg	1905
36	Lilienthal	Lilienthal	1905
37	Patrick[8]	Plummer	1905
38	Keen	Keen	1905
39	Murphy	Murphy	1906
40	Sargent & Buzzard[9]	Sargent	1906
41	Laplace[9]	Laplace	1906
42	Patterson[9]	Patterson	1905



FIGS. 22 and 23.—Front and rear views of Patrick's case (No. 32). Tactile anesthesia, with slight hyperalgesia of the left forearm, slight in degree and with ill-defined border.

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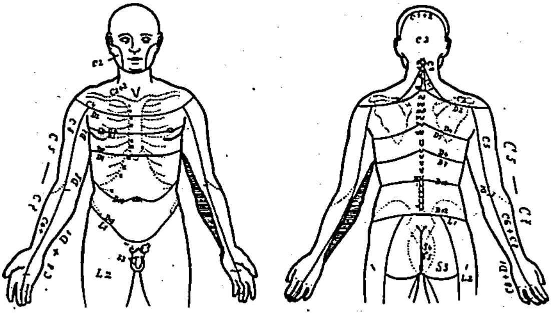
[6] In the Bibliography (arranged alphabetically) the references to all of these cases which have been published will be found. It has not always been clear who was the operator and, therefore, I may have incorrectly stated the name in a few cases. Abstracts of many of the earlier cases are given by Eisendrath, Pilling, and Schönebeck. Of the unpublished cases brief histories are given below. I have to thank the surgeons who have communicated these various cases to me personally.

[7] This case is also reported in Kuester's Inaug. Dissert., Berlin, 1895, and is often referred to as his or as Bardeleben's.

[8] As Dr. Patrick's cases were published in such very brief abstracts, I give here considerably fuller histories, which I owe to his kindness. Cases 38, 41, and 42 are also from notes kindly furnished by the operators.

[9] Not yet published.

After any unusual exertion, pain in the arm was increased; occasionally kept her awake at night. At about the same time she began to notice a numb feeling and paresthesia along the inner border of the left arm, forearm, and hand. Of late she has noticed that the left hand was not so sensitive as the right, and a few days before being examined she burned the ulnar side of the wrist and noticed that it was not normally painful. There was atrophy of the small hand muscles and beginning claw-hand. Measurements showed a difference of ½ inch in the circumference of the hands, ¼ inch in the forearm, and ¾ inch over the biceps. There was slight flattening of the region of the left supraspinatus, slight wasting of the deltoid. In the action of shoving the left scapula "winged" a little more than the right. The grip was slightly weak on the left side and, in grasping strongly, the hand turned slightly toward the radial side. The palpebral fissure was slightly smaller on the left side and in obscure illumination the left pupil was slightly larger than the right. There was slight but distinct thermo-anesthesia along the inner border of the arm and forearm from the wrist (not including the hand and little finger) nearly to the axilla. Along this border there was also some tactile anesthesia, but smaller in area than the thermo-anesthesia (Figs. 22 to 25). There was reaction of degeneration in the small hand muscles.



FIGS. 24 and 25. Front and rear views of Patrick's case (No. 32), same as Figs. 22 and 23. Area of thermo-anesthesia (incomplete) of left arm; border indistinct.

Operation, October 25, 1904, by Dr. William E. Morgan. No particular difficulty was encountered at any stage. The patient made a good recovery from the operation, although she experienced a good deal of pain for the first two or three days. No later history was obtained.

Case 37. Hugh T. Patrick, and S. C. Plummer (personal communication). Woman, aged twenty-four, bookkeeper and stenographer, first seen January 25, 1905. Pain had begun in the right axilla eight years before and had gradually extended down the inner border of the arm, gradually becoming worse. Any overexertion, such as prolonged writing or piano playing, increased the pain, and she positively affirmed that any undue excitement had the same effect. About four years before being seen, she first noticed disability in the fingers, in trying to pick up a pin. Three years before, loss of power in the thumb had reached such a degree that she could not hold a pencil in the ordinary way, and was forced to hold it between the index and middle fingers. By January, 1905, there was not only weakness in the small hand muscles, but the whole right arm was weaker. The pain seemed to start in the axilla and run down to the elbow and middle of the forearm, along the inner border. She had no pain in the hand or fingers, but occasionally pain seemed to extend from the axilla around to the scapular region. She did not know when the wasting had begun, but when she first noticed it two years before examination it had already become quite marked.

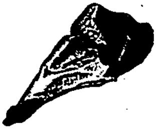


FIG. 26.—Specimen removed in Patrick's Case 37. (Natural size.)

In the history of this case it is rather interesting to note that a diagnosis of writer's cramp had been made by a prominent neurologist, because of the difficulty in writing and the distress caused by it. Measurement showed the right hand, forearm, and arm each ¼ inch smaller than the left.

No distinct anesthesia could be made out. The skiagraph showed not only a cervical rib on the right, the affected side, but also one on the left almost as large. As the left rib has caused no symptoms, of course it has been let alone.

Operation, March 16, 1905, by Dr. S. C. Plummer. Incision, three inches long, from clavicle at posterior border of sternocleidomastoid muscle, obliquely upward and backward. Skin and platysma divided, also a part of trapezius and of sternocleidomastoid, as these two muscles came close together, and the portions cut were quite thin. Brachial plexus exposed. It was not necessary to expose the subclavian artery. The posterior belly of the omohyoid muscle was exposed, and drawn forward and downward, along with the plexus and artery. The scalenus medius was laid bare and retracted backward. There were no muscular attachments to the cervical rib. The cervical rib was now freed and cut off at its base with a chisel. A portion of the remainder of the rib was cut away with rongeur forceps. The rib was 1¼ inches long and ⅜ inch wide at its widest part (Fig. 26). Its anterior end was pointed and connected with the first dorsal rib by a slight ligamentous band. No injury to pleura. Catgut sutures in muscles. Silkworm-gut in skin. No drainage.

After the operation she suffered very considerable pain above the clavicle, about the site of the operation, not under the arm and along its inner border, as heretofore. This pain continued for about six weeks without much change, when it gradually diminished. However, as soon as the patient began to use the arm, such use caused pain in the scapular region, and if the exercise was continued the whole arm began to ache. There has been constant but very slow improvement. The patient was last seen on August 10, 1906, and while the pain and tenderness above the scapula had almost entirely disappeared and she had no pain in the arm when quiet, exertion of almost any kind, if continued for more than twenty or thirty minutes, caused first discomfort, and then a decided ache. As regards atrophy, strength, and function of the hand, it could not be said that there had been any improvement. On the whole, the results of operation were disappointing, although it is reasonable to suppose that improvement will continue for a long time.

Case 38. Francis D. Patterson (personal communication). Woman, aged thirty-five, had suffered from children's diseases; diphtheria at fifteen; quinsy at twenty-one; malaria at twenty-four; rheumatism at thirty-one; typhoid at thirty-four. At twenty-eight she was operated on for an ovarian abscess.

July 19, 1905, at thirty-five years of age, she noticed a swelling on the right side of the neck, with pain in the distribution of the brachial plexus. A cervical rib was diagnosticated. She was operated upon August 2, 1905, by a vertical incision along the posterior border of the sternocleidomastoid. The pleura was punctured and a late pneumothorax developed. Uninterrupted recovery took place, but a pressure paralysis followed, probably as a result of the forcible retraction of the brachial plexus. All the earlier symptoms, caused by the cervical rib, had steadily improved up to January 6, 1906.

Dr. Rhein examined the patient October 26, 1905. There was complete paralysis of all the muscles below the elbow, except that there were feeble pronation and supination. Flexion and extension of the fingers absolutely lost; deltoid unaffected, but pectoral muscles weak; latissimus dorsi, supraspinati and infraspinati intact; biceps and triceps, especially the latter, very weak. Marked tenderness along the nerve trunks. Straightening of the fingers caused great pain. No loss of sensation either to pin-point, heat or cold.

There was some hyperesthesia of the left hand. Faradic contractility was present in all of the muscles, but diminished in the extensors, flexors, triceps, and biceps; the deltoid was normal. There was reaction of degeneration in biceps and triceps, flexors, in the forearm and the small muscles of the hand. The cathodal closures were greater than the anodal in the extensors of the forearm. The prognosis was good.

Case 41. Laplace (personal communication). G. H., aged eighteen, first seen December 4, 1905. On October 17, 1905, while looking out of the window of a train, was frightened by another train passing by, and hurriedly drew his head in, knocking his right shoulder against the window. He was unconscious for about fifteen minutes. When he awoke, he was unable to raise his right arm. Was treated for six weeks by his family physician, without improvement.

Physical Examination. December 4. The patient, though only eighteen, is six feet in height; is quite thin. Has grown very rapidly during the last two or three years. The right shoulder seems especially emaciated. He is unable to raise the right arm. There is considerably atrophy of the deltoid, biceps, and triceps. He is, however, able to flex the forearm and retains the power of pronation and supination. Sensation has remained about normal. Says that he is getting worse since the accident. Considerable bulging was noticed on the right side of the neck. On pressure it was found quite hard and gave considerable pain. The presence of a cervical rib was then suspected. An *x*-ray photograph revealed a cervical rib on both sides, though better marked on the right.

Operation, January 25, 1906. A curved incision was made in the posterior triangle commencing at the centre of the posterior margin of the sternomastoid, curving backward and downward to the anterior margin of the trapezius and then forward along the clavicle to the sternomastoid again. The flap was raised forward, and the deep facia was opened. The sternomastoid was pulled forward, and the subclavian artery and brachial plexus were defined lying upon the rib. The periosteum was incised and the rib was bared. It was found fixed at both extremities. Below, it seemed to be inserted into the sternoclavicular articulation. About four inches of rib was resected with cutting pliers and carefully shaved down so as not to leave any marked projection or sharp edge, against which the vessels or nerves might be damaged. The periosteum was then resected. The wound healed without trouble, but as yet the paralysis of the circumflex and subscapular nerves has not been relieved. About ½ inch of the rib was left adherent at its anterior insertion, fearing to wound the subclavian artery and vein by working any deeper.

Case 42. Mr. Percy Sargent and Dr. Farquhar Buzzard, of London (personal communication). Woman, aged forty-nine.

For ten years she had complained of inconstant dull aching pain in the ball of the right thumb; worse in evening and after muscular exertion. Three or four years ago numbness in tips of right thumb and forefinger was observed. One year ago atrophy of the ball of the right thumb was noticed, and at the same time she began to have aching pain in the internal aspect of the right forearm and over the deltoid. She had occasional pain above the right clavicle. A year ago the numbness extended to the tip of the middle finger. On admission the only muscle affected was the right abductor pollicis; the thumb movements were scarcely interfered with excepting in abduction. For the sensory area, see diagram (Fig. 27). A skiagraph revealed bilateral cervical ribs, but they could not be definitely felt. The subclavian arteries were raised well above their usual levels.

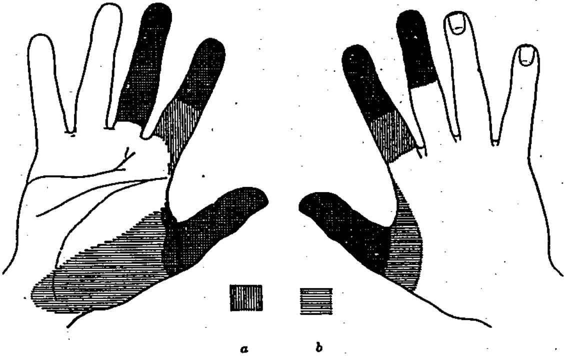


FIG. 27.—Case of Sargent and Buzzard (No. 42). *a*, diminished sense of pain; *b*, diminished tactile sense. The darkest areas represent diminution of both.

Operation, July 17, 1906, by Mr. Sargent. Triangular flap of skin corresponding to posterior cervical triangle; exposure of plexus; complete rib found, articulating with the seventh cervical and attached to the first rib. An angular prominence existed in the middle. "There was no indication that any part of the plexus was pressed or dragged upon in any way."

After operation the whole upper extremity was extremely weak. Sensation was unaffected. September 15, 1906: the arm is recovering, but there is still some wasting of the spinati, deltoid, biceps, and triceps. Sensation is the same as before operation. No definite electrical changes exist in any muscle. October 23, 1906: recovery of muscles of the fifth cervical segment is very slow.

POSTSCRIPT.

After this paper was in print, Dr. J. M. Spellissy, of Philadelphia, reported at the Academy of Surgery of Philadelphia the following case. I owe to his kindness the advance notes of the case before publication and also the photograph of the most complete specimen of cervical rib which I know. It shows a most extraordinarily deep groove for the subclavian artery (Fig. 28).

M. R., aged twenty years, was first seen in May, 1905, for a painful right shoulder, following a fall over two years previously. Examination showed a sternal luxation of the right clavicle and the presence of a right cervical rib. A skiagraph confirmed the diagnosis. There was no cervical rib on the left side. Excision was done by Dr. Spellissy on May 22, 1905. The anterior end of the cervical rib articulated with the first dorsal. This end was disarticulated, and after freeing the under surface of the rib and dissecting the artery loose for 5 cm., with considerable difficulty the artery was displaced over the anterior end of the rib. The rib was then disarticulated from the seventh cervical vertebra. The patient made a good recovery.

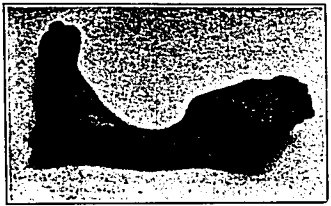


FIG. 28.—Cervical rib (natural size), with very deep groove for the subclavian artery. (Spellissy's case).

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COMPULSORY VACCINATION, ANTIVACCINATION, AND ORGANIZED VACCINATION.

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The antivaccination movement in the United States is becoming widespread and troublesome. The first suit at law against legalized vaccination was brought in 1890.[1] Since then there have been many, and although the decisions almost unanimously favor the health authorities, litigation seems on the increase.

For the last eight years we have been passing through an epidemic of smallpox, and this showed, in strong colors, the need of more vaccination rather than less. I believe that legal regulation is needed, but I also think, and shall try to show, that our present laws are unsatisfactory in their results. If laws are made, they should be so constructed and enforced as to secure the sanction of public opinion. I need not discuss the fiction that in a republic all laws come from the people. This at least is true, that some kinds of laws cannot be enforced unless they have popular acquiescence. Unpopular health laws affecting the person will find difficulties such as arise in the execution of sumptuary laws, like those regulating the use of tobacco and alcoholic beverages. Even among people with despotic or paternal government, with highly organized civil service and active police, vaccination is sometimes defeated. Mothers suck out the virus from their children's arms with great danger to themselves; older subjects wash out their wounds; dishonest physicians give false certificates; venal officials connive. In our own country some legally qualified practitioners of medicine are opposed to vaccination and give certificates for absurd substitutes, such as variolinum, or diluted smallpox virus, given by the mouth.

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[1] Abeel vs. Clark, 84 Cal., 226.